Research Note

Morphological differences between zebra and quagga mussel spermatozoa

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Abstract: Sperm morphology of the zebra mussel, *Dreissena polymorpha* (Pallas, 1771), and of the currently-unnamed quagga mussel are described from light and scanning electron microscopy. Differences in shape of the sperm head and acrosome are described as a potentially useful tool in distinguishing the two species.

There are currently two species of dreissenid mussels that have invaded North America. The appearance of the first species, *Dreissena polymorpha* (Pallas, 1771), was described by Hebert *et al.* in 1989. A description of a second species, whose identity is not known but which is currently called the quagga mussel, was made by May and Marsden in 1992**. In addition to genetic differences, the two species differ in shell morphology (Pathy and Mackie, 1993). The quagga mussel lacks the acute angle or carina between the ventral and dorsal surfaces of the zebra mussel shell. This difference in shell morphology can be difficult to discern in some mussels, especially to those who examine mussels only occasionally. The difference in sperm morphology described in this note could be helpful in the positive distinction between male zebra and quagga mussels.

As a part of an ongoing study of the reproductive cycle of zebra mussels, samples of quagga mussels were also examined to determine if there were differences in the reproductive patterns of the two species. Upon examination of fixed and stained soft tissues of mussels under light microscopy, it became apparent that there were clear and consistent differences in gross morphology of the spermatozoa. Examination of simple squash preparations of small amounts of viscera from live specimens revealed that differentiation between males of the two species was possible without extensive sample preparation. To examine the morphological differences more closely, zebra and quagga mussel spermatozoa were examined by scanning electron microscopy.

The mussels examined were collected on 22 July 1993 from the Black Rock Lock adjacent to the Niagara River in Buffalo, New York. Both zebra and quagga mussels were found at the same site. For electron microscopy, squashes of a small portion of the visceral mass from several individuals of each species were made for quick determination of sex. The remaining tissues were fixed for two hours at 7°C in 2.5% glutaraldehyde and 0.1 M cacodylic acid, pH 7.2. Tissues were then washed three times in 0.1 M cacodylate buffer followed by 2% osmium tetroxide solution for ten minutes each. The samples were dehydrat-

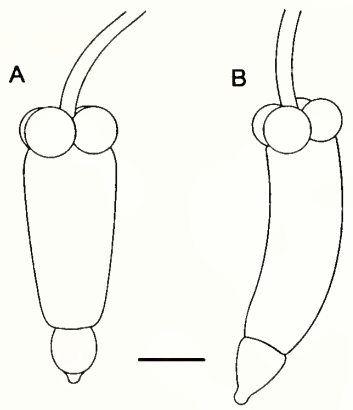

Fig. 1. Comparison of the spermatozoan morphology of zebra mussel (A) and quagga mussel (B). Scale = 1 µm.

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**The quagga mussel has since been identified as *Dreissena bugonsis* Andrusov, 1897, by G. Rosenberg and M. L. Ludyanskiy, and A. P. Spidle, J. E. Marsden and B. May in two publications to appear in volume 51 of the *Canadian Journal of Fisheries and Aquatic Sciences.*

ed stepwise in a series of solutions containing 50, 60, 75, 90 and 100% ethanol. Tissues were dried in a critical point dryer before being coated with gold under an argon atmosphere. The prepared samples were examined using an Electroscan environmental scanning electron microscope.

The sperm heads of zebra mussels are straight, short, and blunt, whereas those of the quagga mussel are curved, longer, and more pointed, somewhat reminiscent of a scaphopod shell (Fig. 1). The difference in morphology is apparent even in an unstained squash preparation under relatively low magnification (400X). Electron photomicrographs show the described differences clearly (Figs. 2 -3).

Measurements using electron photomicrographs revealed that the mean length of *Dreissena polymorpha* sperm heads is 4.0 ± 0.1 µm (N = 5), whereas that of quagga mussels is 4.7 ± 0.2 µm (N = 7). Mean width of zebra mussel sperm at the widest point is 1.6 ± 0.1 µm (N = 4), as compared to 1.3 ± 0.1 µm (N = 4) in quagga mussels. The zebra mussel sperm head is more bulbous in appearance

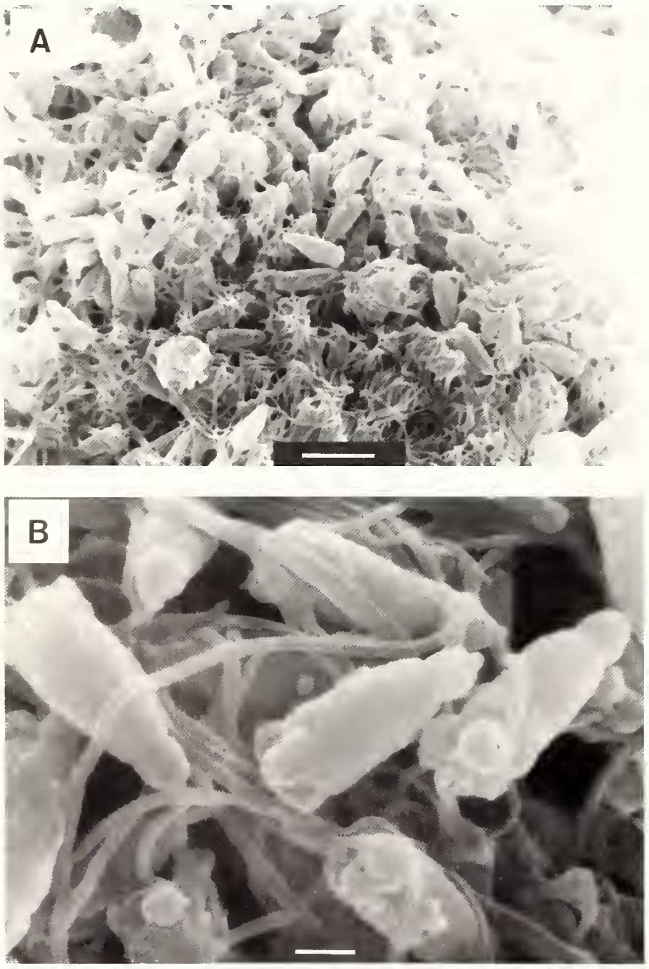

Fig. 2. Scanning electron photomicrographs of the spermatozoa of zebra mussels. Scale = 5 µm (A), 1 µm (B).

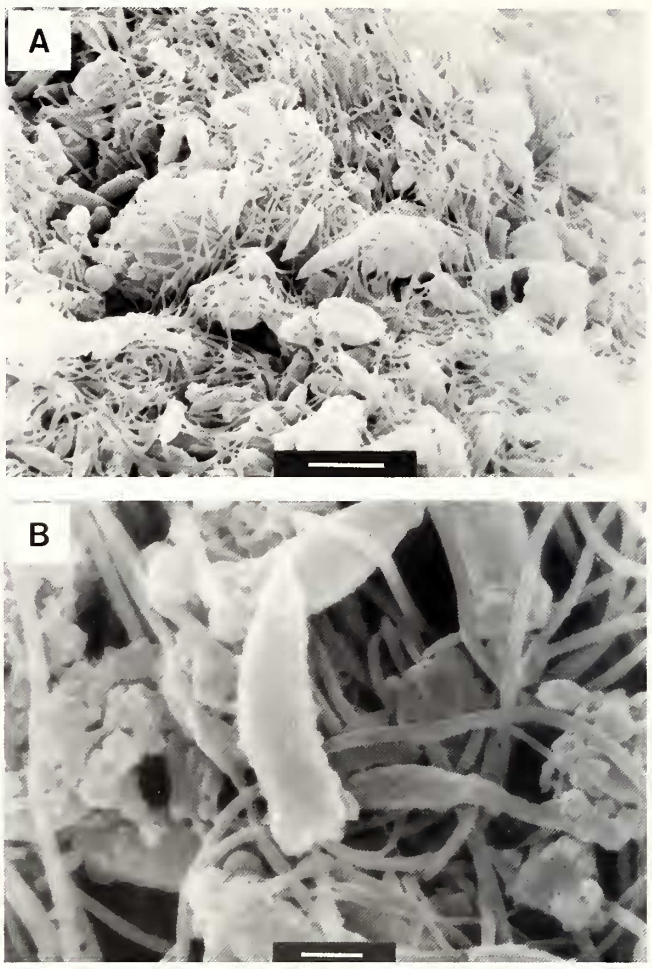

Fig. 3. Scanning electron photomicrographs of the spermatozoa of quagga mussels. Scale = 5 µm (A), 1 µm (B).

than that of the quagga mussel sperm, which has a more sharply pointed outline. Again, the most distinguishing feature is the straight, short appearance of zebra mussel sperm in contrast to the curved, longer appearance of quagga mussel sperm.

Differences are also apparent between the acrosomes of the two sperm types. In the zebra mussel, the acrosome is more bulbous and oval in shape than that of the quagga mussel. In the latter species, the acrosome is wide at the point of attachment to the rest of the sperm head, but tapers more sharply toward the tip. In both types, the primary acrosome vesicle is visible as a small nib at the apex of the acrosome. This structure is functionally important, as its membrane covering disarticulates at fertilization to fuse with the plasma membrane of the ovum (Dan, 1970).

Spermatozoa of both zebra and quagga mussels possess elongated flagella, which are at least several times the length of the head portion. Flagella of the sperm of both species project from the broad base of the head, and this

junction is surrounded by four rounded structures which contain mitochondria (Mackie, 1984).

Sperm morphology has been used as a tool in the study of systematic zoology by a number of workers. Such investigations have included oligochaetes (Jamieson, 1984), ascidians (Franzen, 1992), and rodents (Roldan *et al.*, 1992). In addition, similar studies of gastropod spermatozoa have been employed in the examination of congeneric limpets (Hodgson and Bernard, 1988; Jamieson *et al.*, 1991).

With regard to mussels, if positive distinction between the two species of *Dreissena* based on shell morphology is not possible, the described differences in the appearance of the sperm could be helpful. Of course, the usefulness of this technique is limited to male mussels, and only to that part of the reproductive cycle during which sperm are present, generally between March and September.

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